ULTRASOUND FINDINGS OF POPLITEAL ARTERY ENTRAPMENT AND US-GUIDED HYDRODISSECTION OF SCAR OF THE PATELLAR RETINACULUM

Patricia B, Delzell, MD
PRiSM Charter Member
President, Advanced Musculoskeletal Medicine Consultants, Inc
Novelty, OH

DISCLOSURES

- Siemens Ultrasound Consultant

OBJECTIVES

- Demonstrate the effect of dynamic ankle plantar flexion and dorsiflexion on popliteal artery Doppler waveforms in patients with clinically suspected fPAES and no structural abnormality.
- Describe the preliminary data comparing the ultrasound findings of fPAES to patient outcomes with different treatment plans.
- Describe the technique for ultrasound guided hydrodissection of patellar retinacular scar and the preliminary short-term outcomes results following this treatment.

ACKNOWLEDGEMENTS

- Fatemeh Abdollahi Mofakham, MD, MSK Radiologist
- Jason Genin, DO, Primary Care Sports Medicine
- Paul Saluan, MD, Orthopedic Surgeon
- Jennifer Bullen, MS, Biostatistician

MSK Ultrasound Technologists

FUNCTIONAL POPLITEAL ARTERY ENTRAPMENT

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- Functional popliteal artery entrapment syndrome (PAES)
  - In the DDX of exertional leg pain
  - Difficult imaging diagnosis as it is caused by dynamic biomechanical compression.
  - True incidence is unknown. Likely underdiagnosed and underreported.
  - No current guidelines for diagnosing fPAES based on grayscale and spectral Doppler US findings.

ULTRASOUND PROTOCOL FOR POPLITEAL ARTERY ENTRAPMENT

- **Anatomic screen to exclude anatomic PAES**
- **Before and after exercise:**
  - **Dynamic cine clip through popliteal fossa during ankle plantar flexion and dorsiflexion.**
  - **Measured Peak Systolic Velocity (PSV)**
    - **Above level of entrapment or, if no dynamic entrapment, above level of popliteus muscle**
      - **Neutral**
      - **Plantar flexion**
      - **Dorsiflexion**

DYNAMIC CINE CLIP THROUGH POPLITEAL FOSSA TECHNICAL CONSIDERATIONS

- Patient prone
- Feet hanging off the edge of the examination bed and far enough away from the far wall that the patient can plantar-flex and dorsiflex in the extreme.
- Speed of patient movement
- Speed of transducer translation

PATIENT POSITIONING

DYNAMIC CINE CLIP THROUGH POPLITEAL FOSSA TECHNICAL CONSIDERATIONS

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DYNAMIC MOVEMENT

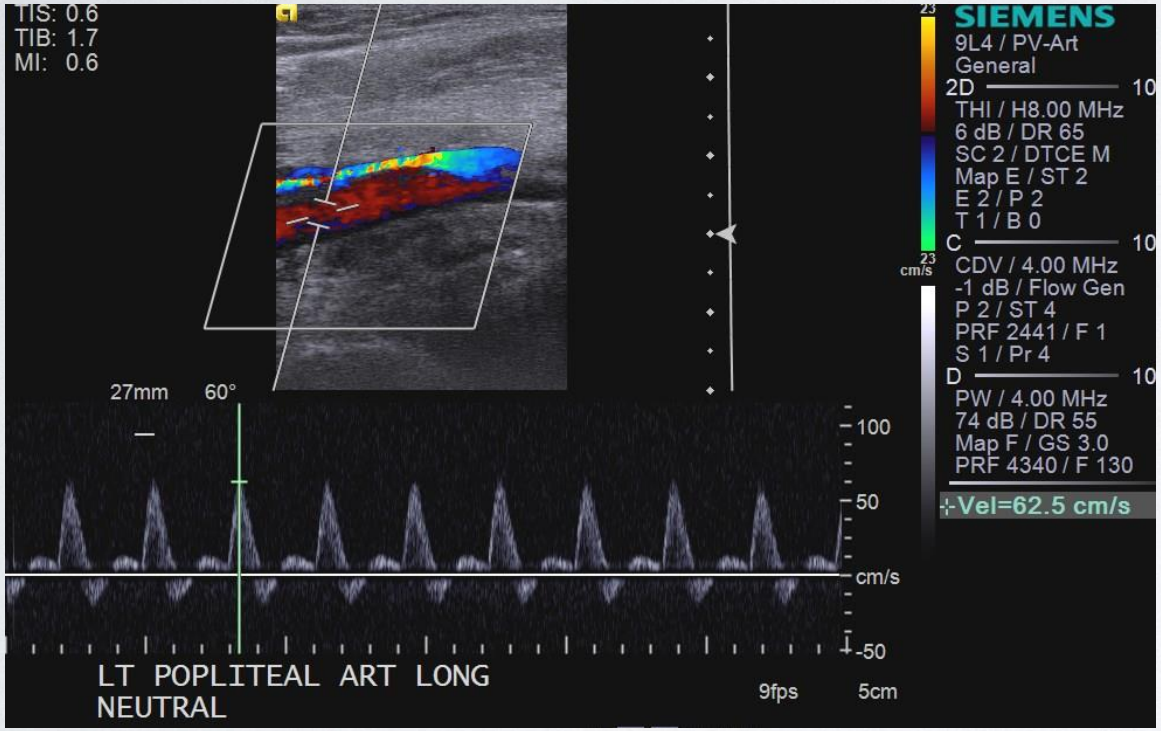
Normal Dynamic

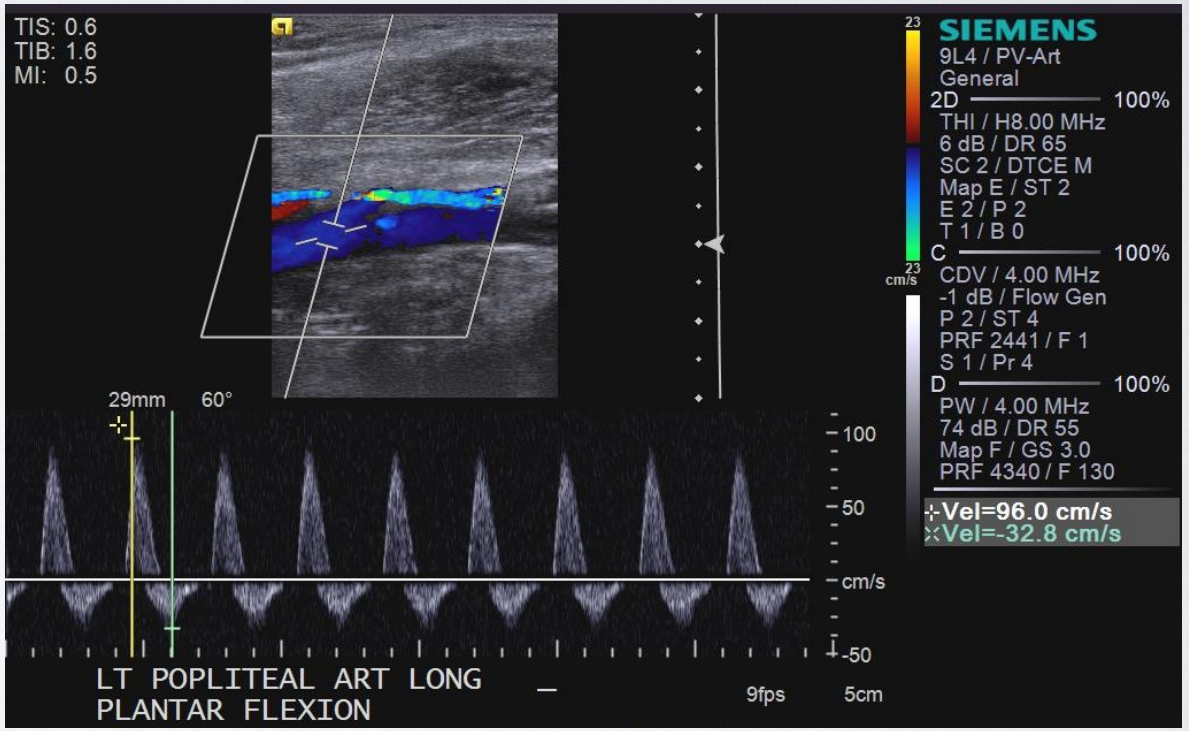
Dynamic Popliteal Artery Compression

FPAES DOPPLER TECHNICAL CONSIDERATIONS

- **Usual doppler proper technique (size of sampling cursor, placement of cursor in the center of the artery, angle correction, etc)**
- **Doppler in the same location for all positions**
- **Need to assess the doppler change right after the position changes because it is not a fixed stenosis so the waveform will equalize once unless severe.**
- **Artery moves side to side and deeper with plantar flexion so need to prepare by having the patient change ankle position, move cursor onto the position of the artery, have the patient relax, turn on the doppler first without moving the cursor and reposition the patient.**
- **Even if no change on pre-exercise, can be dramatically abnormal on the post-exercise so don't skip it.**
- **If borderline on pre and post-exercise (ie see compression but the velocities are not what you expect), look for aberrant vessels and perform in standing (neutral and on toes).**

FPAES DOPPLER EVALUATION

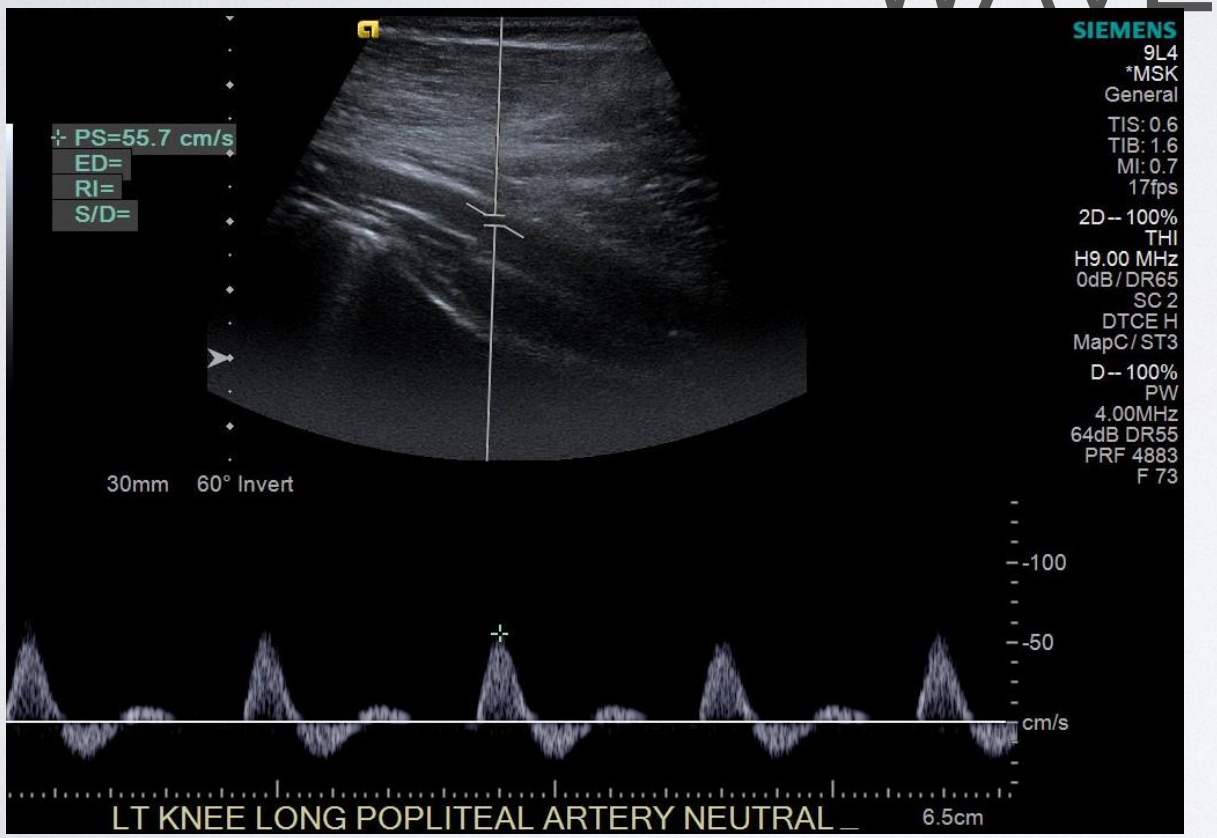




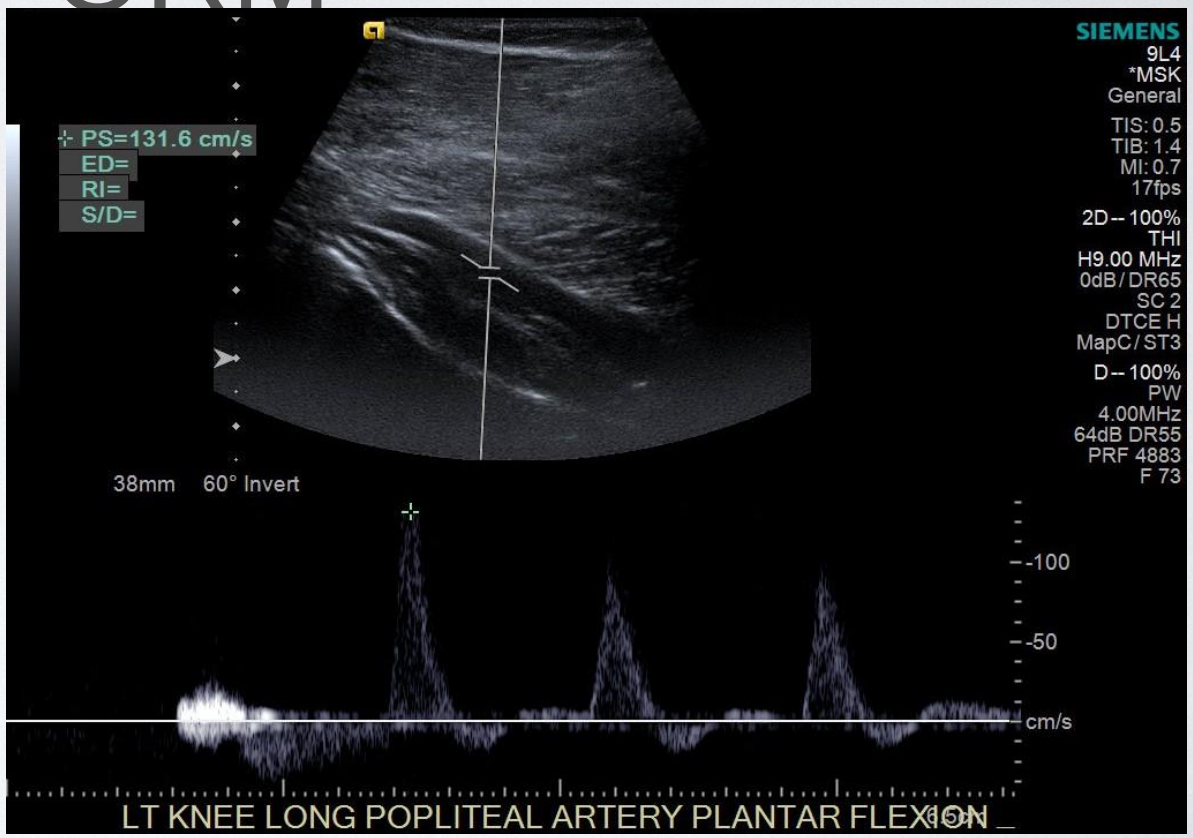
Neutral (62.5 cm/sec)

Plantar flexion (96.0 cm/sec)

FPAES DOPPLER EVALUATION WITH LARGE MOVEMENT OF THE VESSEL AND EARLY EQUALIZATION OF THE WAVEFORM



Neutral (55.7 cm/sec)



Plantar flexion (131.6 cm/sec)

RETROSPECTIVE STUDY AT CCF PERFORMED 2015-2019

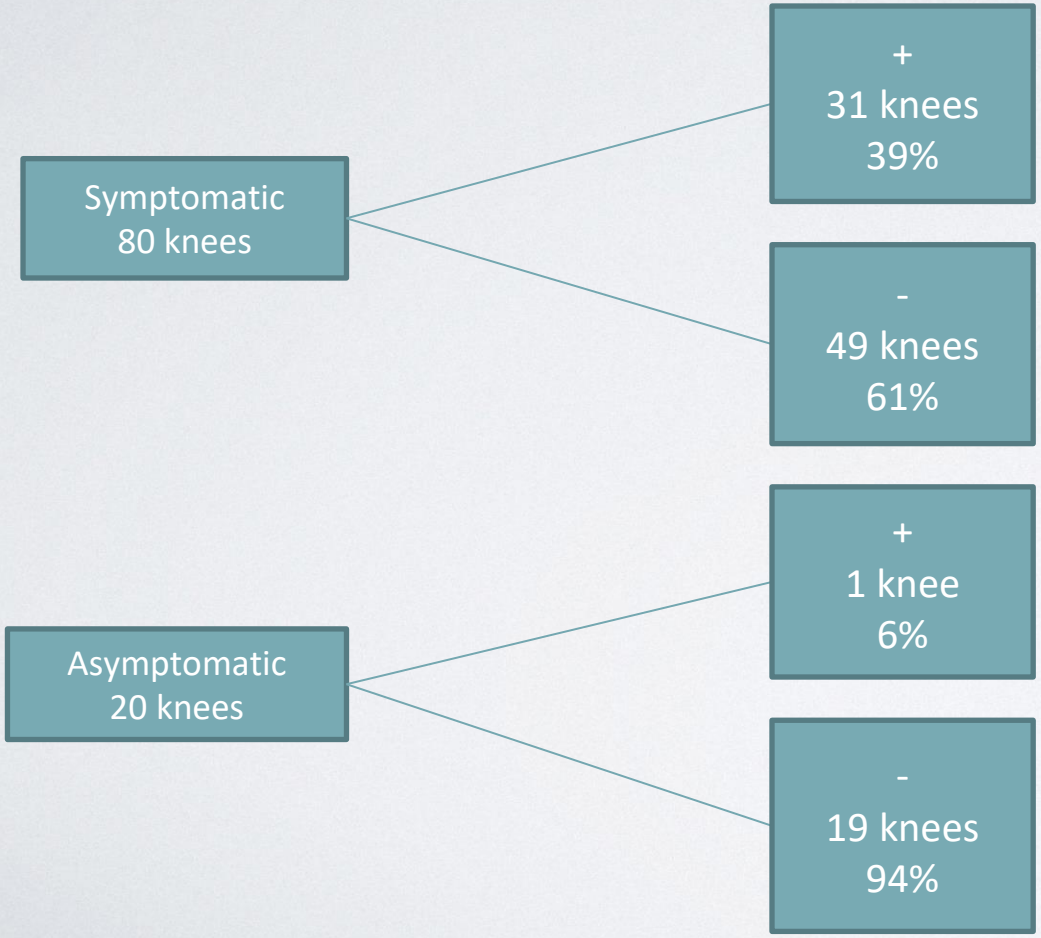
- **Retrospectively reviewed ultrasounds of patients referred for clinically suspected fPAES over a 4-year period compared to asymptomatic controls:**
    - **Dynamic compression**
    - **Change in PSV from neutral to plantar- and dorsi-flexion**
- **1-year outcome data from chart review:**
    - **Presence of alternative diagnoses**
    - **Treatment plans**
    - **>75% subjective improvement in symptoms**

RESULTS: DEMOGRAPHICS

- Patient population:
  - 77% Female
  - Mean age 27 years old (range 14-40)
- 100 knees
  - 80 symptomatic
  - 20 asymptomatic

RESULTS: ULTRASOUND FINDINGS

Popliteal artery compression

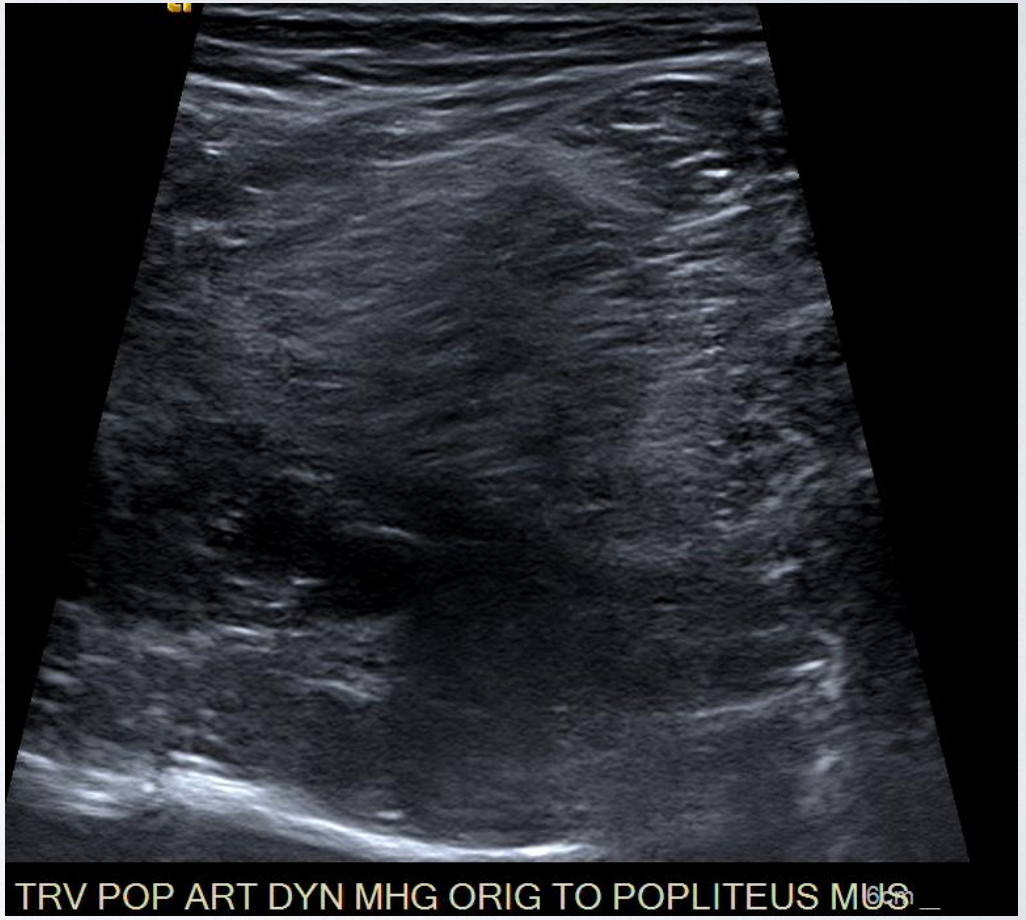


-60% compressed at the popliteus muscle level

-40% compressed at femoral condyles between the gastrocnemius heads.

Compression between gastrocnemius muscles

Compression at popliteus muscle

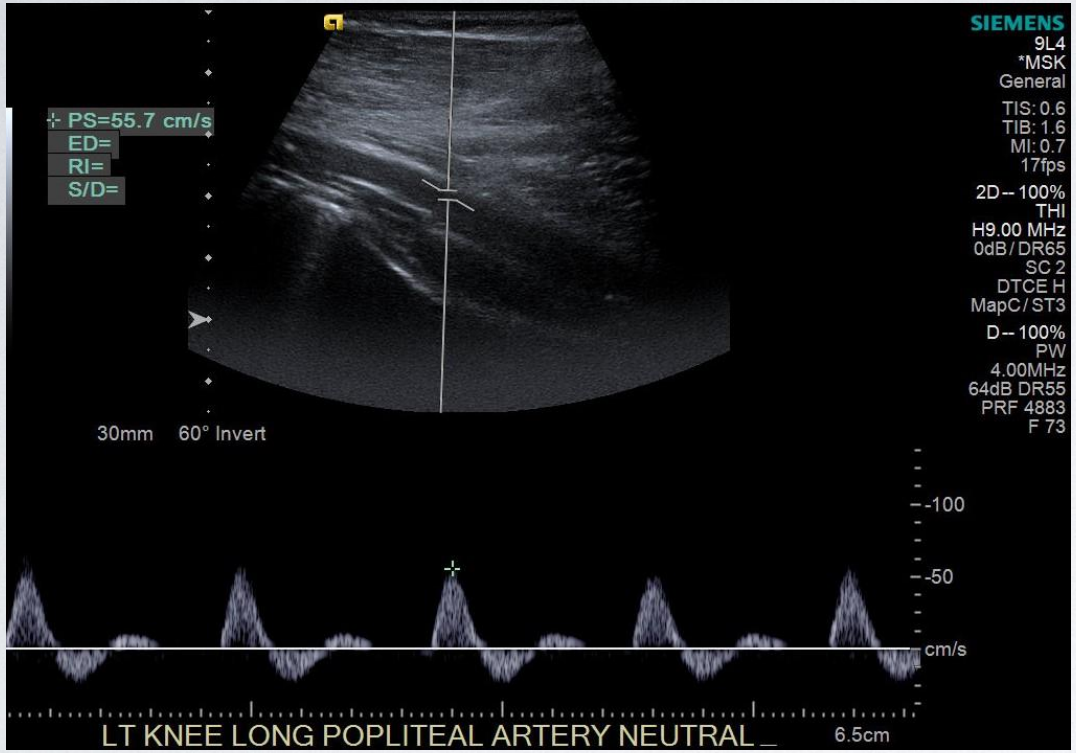


Results: Ultrasound Findings

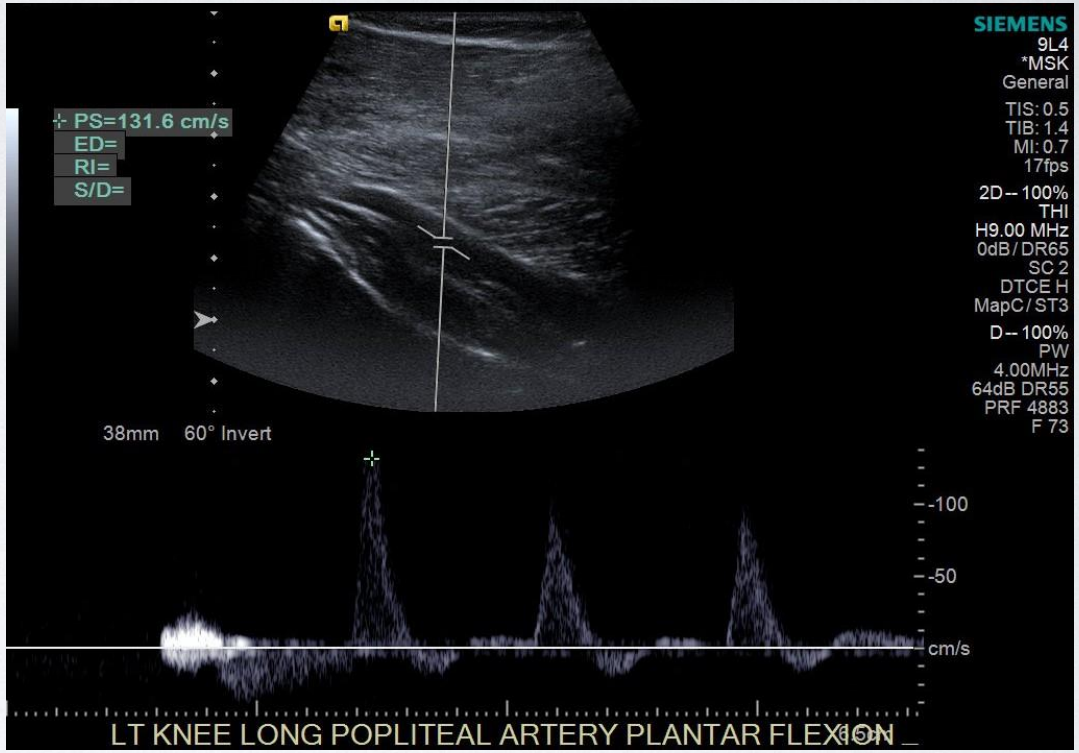
	Knees without visual compression of artery N = 68	Knees with visual compression of artery N = 32	p-value
Absolute change in PSV (cm/s) from neutral to plantar flexion (Pre-Exercise)	12 (± 10)	31 (± 27)	0.001
Absolute change in PSV (cm/s) from neutral to plantar flexion (Post-Exercise)	14 (± 13)	40 (± 25)	<0.001
Absolute change in PSV (cm/s) from neutral to dorsiflexion (Pre-Exercise)	11 (± 8)	17 (± 11)	0.015
Absolute change in PSV (cm/s) from neutral to dorsiflexion (Post-Exercise)	15 (± 13)	17 (± 13)	0.305

Table 1 – Absolute change in PSV during flexion among knees with artery compression and knees without artery compression. Summaries are mean (± standard deviation).

Neutral Position



Plantar Flexion

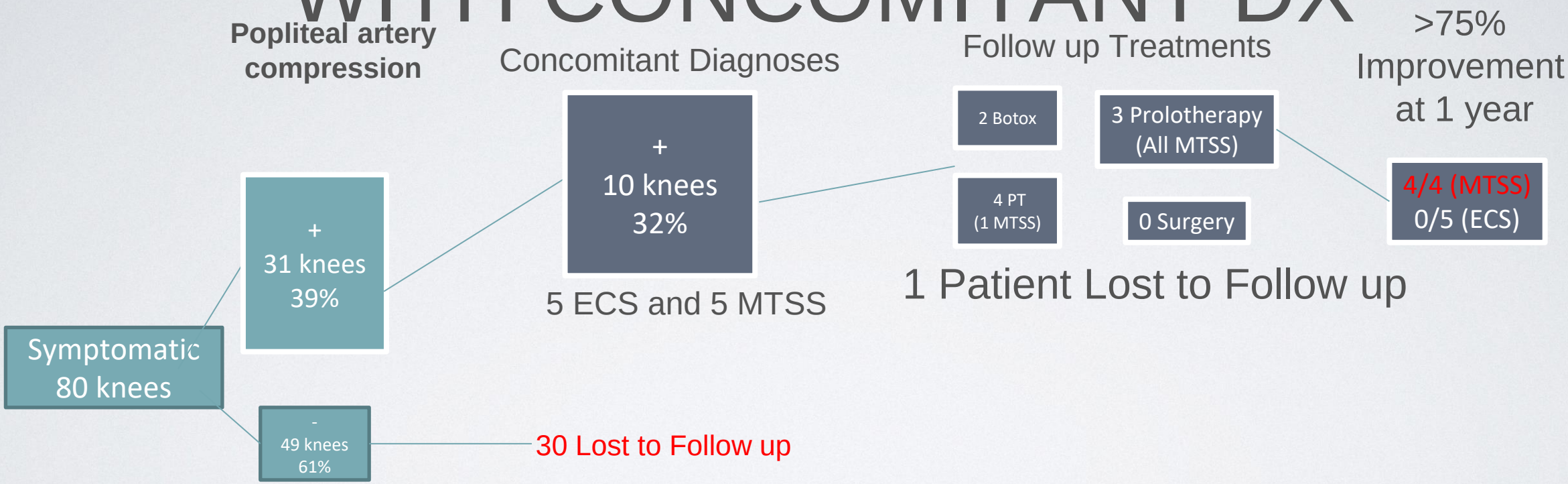


PSV = 55.7 cm/s

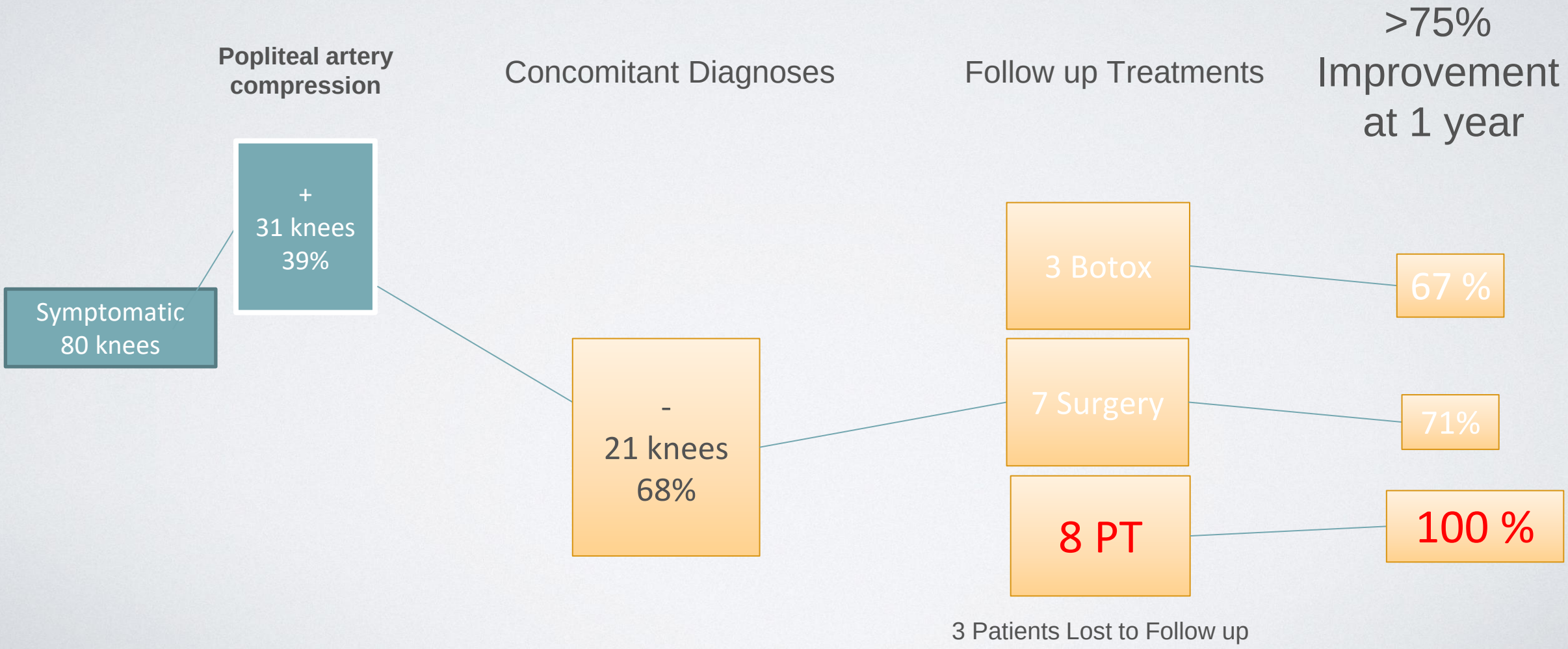
PSV = 131.6 cm/s

-No trends were seen in waveform shape.

CLINICAL FOLLOW UP OBSERVATIONS: FPAES ON US WITH CONCOMITANT DX



CLINICAL FOLLOW UP OBSERVATIONS: FPAES ON US WITHOUT CONCOMITANT DX



LIMITATIONS

- Retrospective
- No standing plantar flexion or measurable force of muscle contraction
- No gold standard as a functional compression model to evaluate optimal location of measurements or expected waveform/velocity change in different scenarios

ULTRASOUND CONCLUSIONS

- Dynamic ultrasound demonstrated popliteal artery compression in 39% of symptomatic knees.
- Before and after exercise, PSV was significantly elevated from neutral to plantar flexion in knees with dynamic arterial compression.
- Additional studies are needed to determine whether this technique may be useful as a diagnostic screening test.

CLINICAL OBSERVATION CONCLUSIONS

- Patients with dynamic compression of popliteal artery and clinical MTSS may have benefit from prolotherapy or PT.
- Biomechanical treatments such as PT may be as beneficial as surgery in fPAES.

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GUIDED LIDOCAINE HYDRODISSECTION OF POSTSURGICAL OR POSTTRAUMATIC SCAR OF THE PATELLAR RETINACULUM

POSTSURGICAL OR POSTTRAUMATIC SCAR OF THE PATELLAR RETINACULUM

- Anterior knee pain is a common complaint particularly in young, active people. The pain can interfere in everyday activities, particularly exercise or athletics.
- Scar formation is a known complication of injury or surgery.
- Up to a quarter of patients who have patellofemoral instability or dislocation have persistent pain after surgery. A subset are localized to the retinaculum focally or to an arthroscopic port.

SURGICAL RESECTION OF LOCALIZED SEGMENTS OF PAINFUL RETINACULUM

- **Kasim, N, Fulkerson, JP, Resection of Clinically Localized Segments of Painful Retinaculum in the Treatment of Selected Patients with Anterior Knee Pain, Am J Sports Med. 2000 Nov-Dec;28(6):811-4.**
- **25 patients with refractory anterior retinacular knee pain.**
- **VAS Questionnaires plus details of prior procedures.**
- **Age average 25yo of onset of symptoms with average of 10 months of symptoms prior to the surgery.**
- **No prior surgery in 5 of the patients. Range 1-6 surgeries for the other 15 patients.**
- **88% moderate-to-substantial improvement after surgery. Average follow-up 4.2 years.**
- **Fibrosis, vascular proliferation and neuromata seen on surgical specimens.**

CURRENT TREATMENT OF POSTSURGICAL OR POSTTRAUMATIC SCAR OF THE PATELLAR RETINACULUM

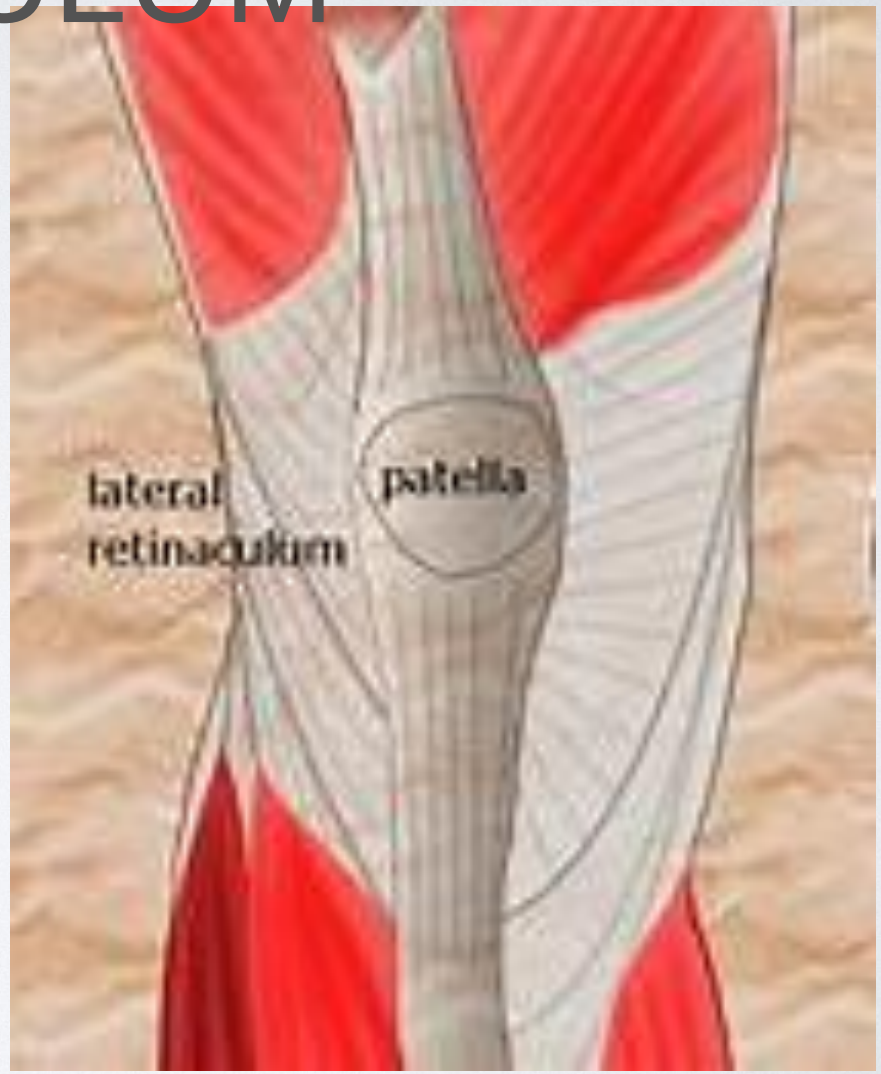
- Physical therapy (PT) targeted to soft tissue mobilization, balance of the entire kinetic chain, and restoration of the patella homeostasis is the standard of conservative care for patients with patellofemoral instability or dislocation who have persistent postsurgical or posttraumatic pain and retinacular scar formation.

ULTRASOUND OF PATELLAR RETINACULUM

- In the event of failed physical therapy or painful knee after surgery, no ultrasound diagnostic evaluation or ultrasound-guided therapeutic treatment for retinacular scar has been described in the literature.

ANATOMY OF PATELLAR RETINACULUM

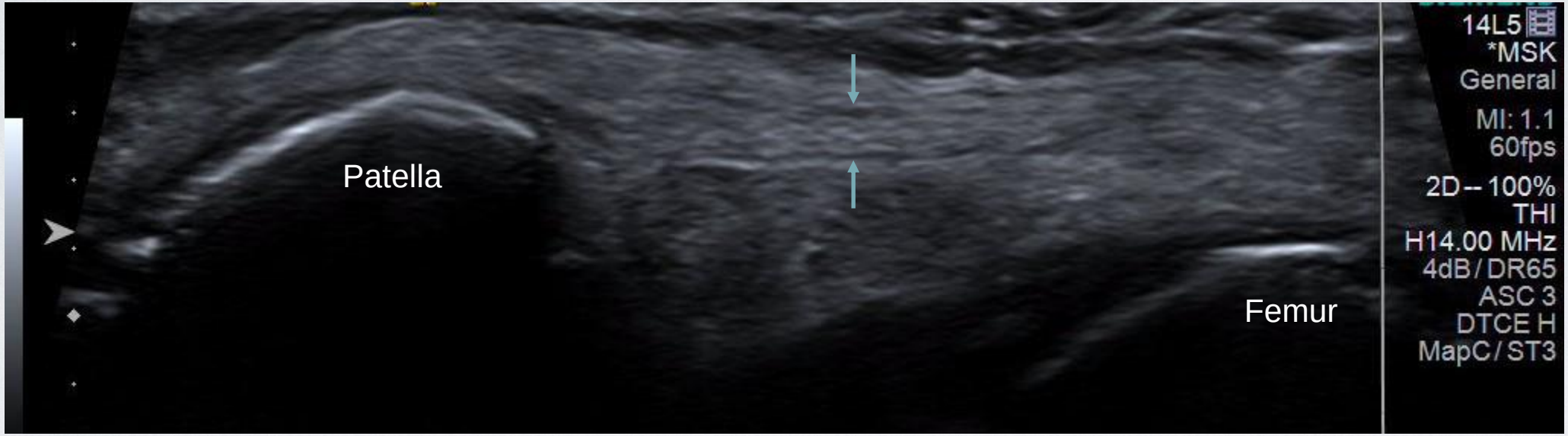
- Fibrous bands made of dense connective tissue that are extensions of multiple lateral and medial structures (oversimplified).
- Inserts onto the patella, quadriceps tendon and patellar tendon. Extends to blend with the knee capsule and inferior surface of the lateral tibial condyle



ULTRASOUND OF PATELLAR RETINACULUM

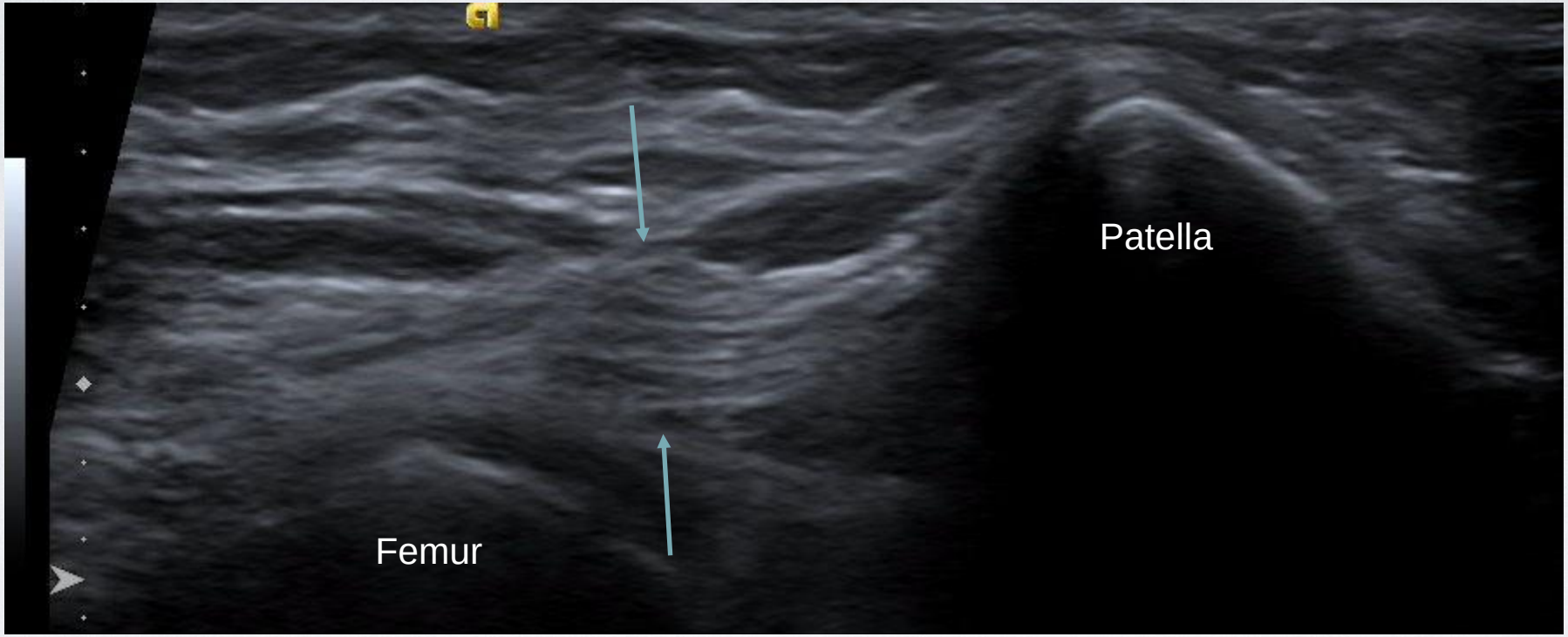
- Scan in the longitudinal and transverse plane from above the patella to the insertion of the patellar tendon.
- Most of the scar is along the anterior portion of the retinaculum (in my experience).
- Always scan the area of pain!
- “Squeeze” test: while scanning over the area of scar, manipulate the underlying fat by massaging the soft tissues adjacent to the transducer, assess for tethering.

ULTRASOUND OF NORMAL RETINACULUM

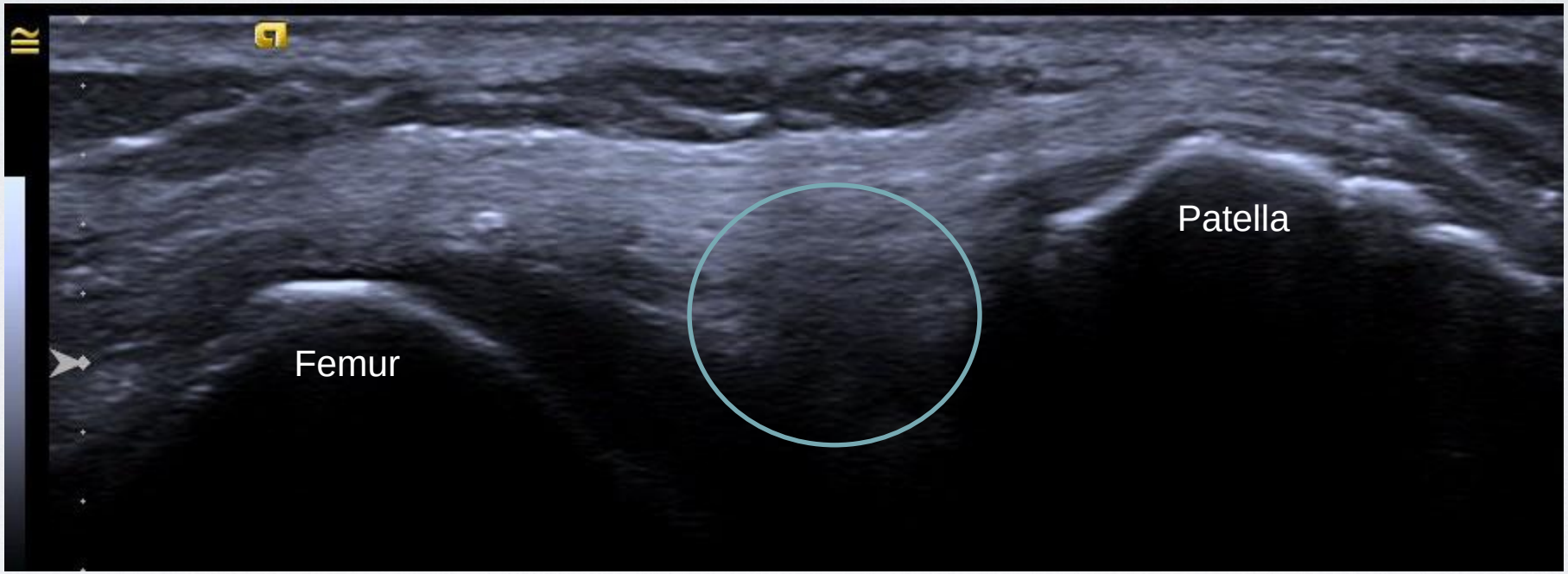


Echogenicity will depend on angle of transducer

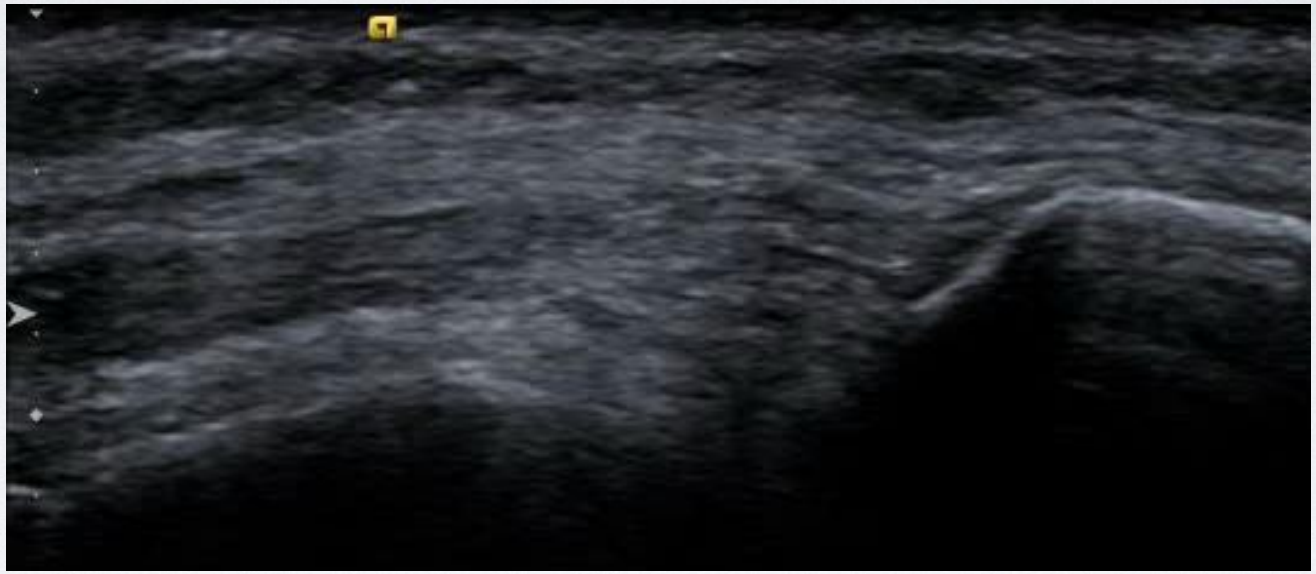
ULTRASOUND OF RETINACULAR SCAR



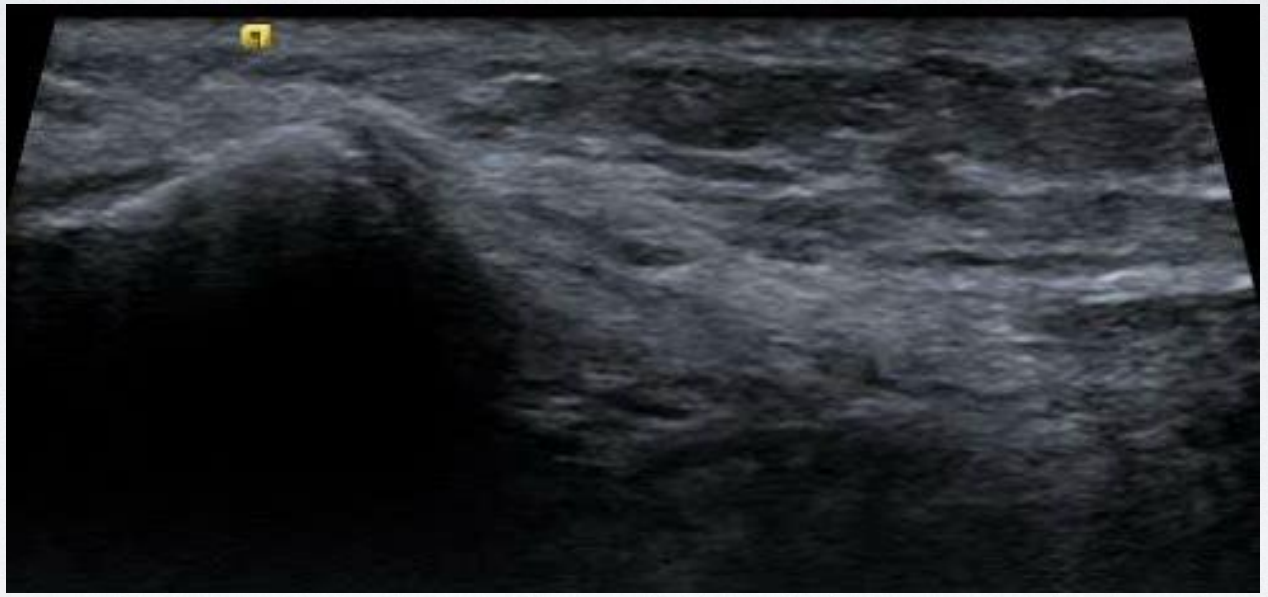
RETINACULAR SCAR TETHERING TO THE UNDERLYING FAT



DYNAMIC FAT TETHERING ASSESSMENT: NORMAL MOTION



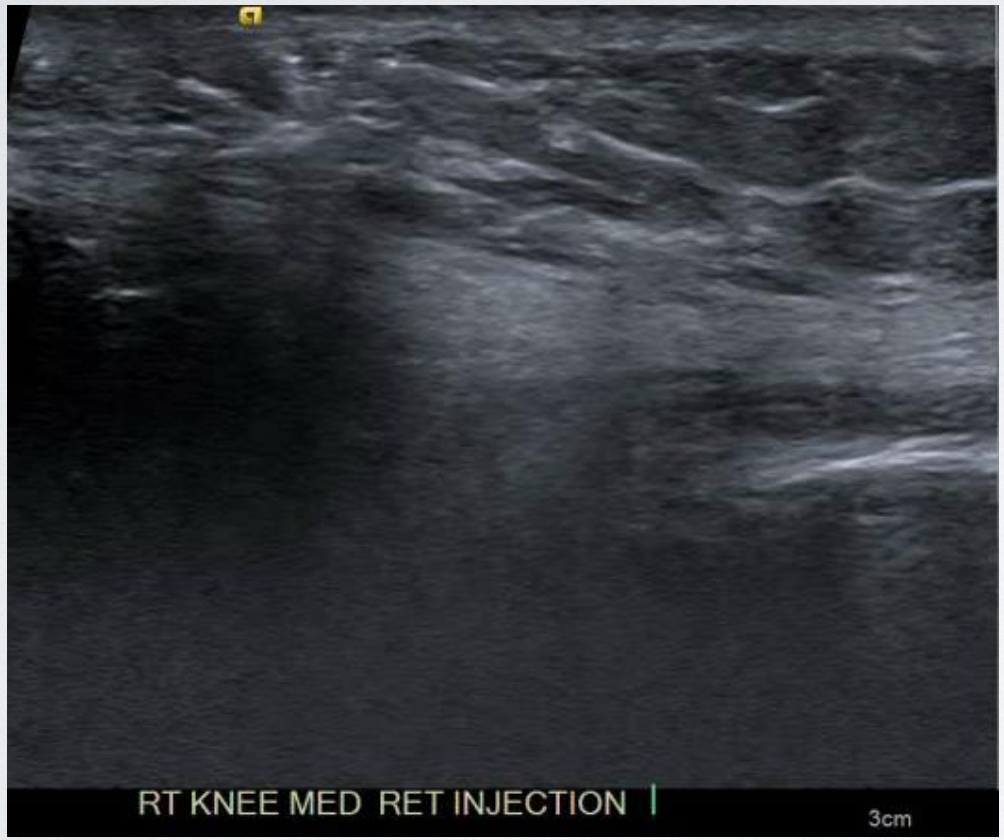
DYNAMIC FAT TETHERING ASSESSMENT: ABNORMAL MOTION

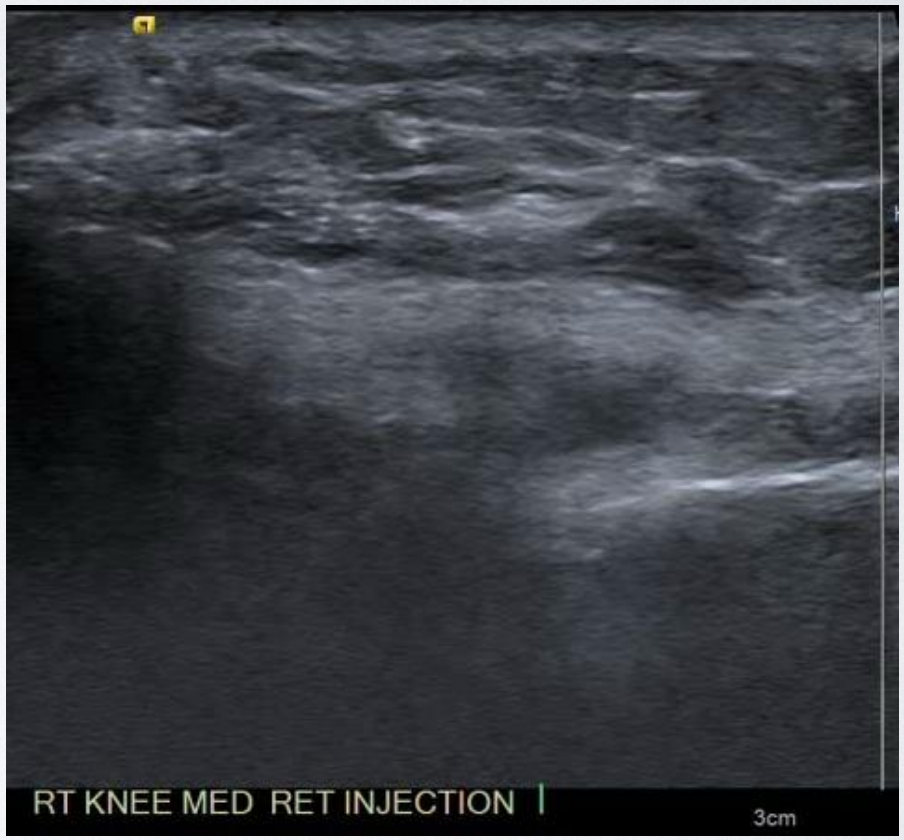


ULTRAOUND-GUIDED HYDRODISSECTION TECHNIQUE

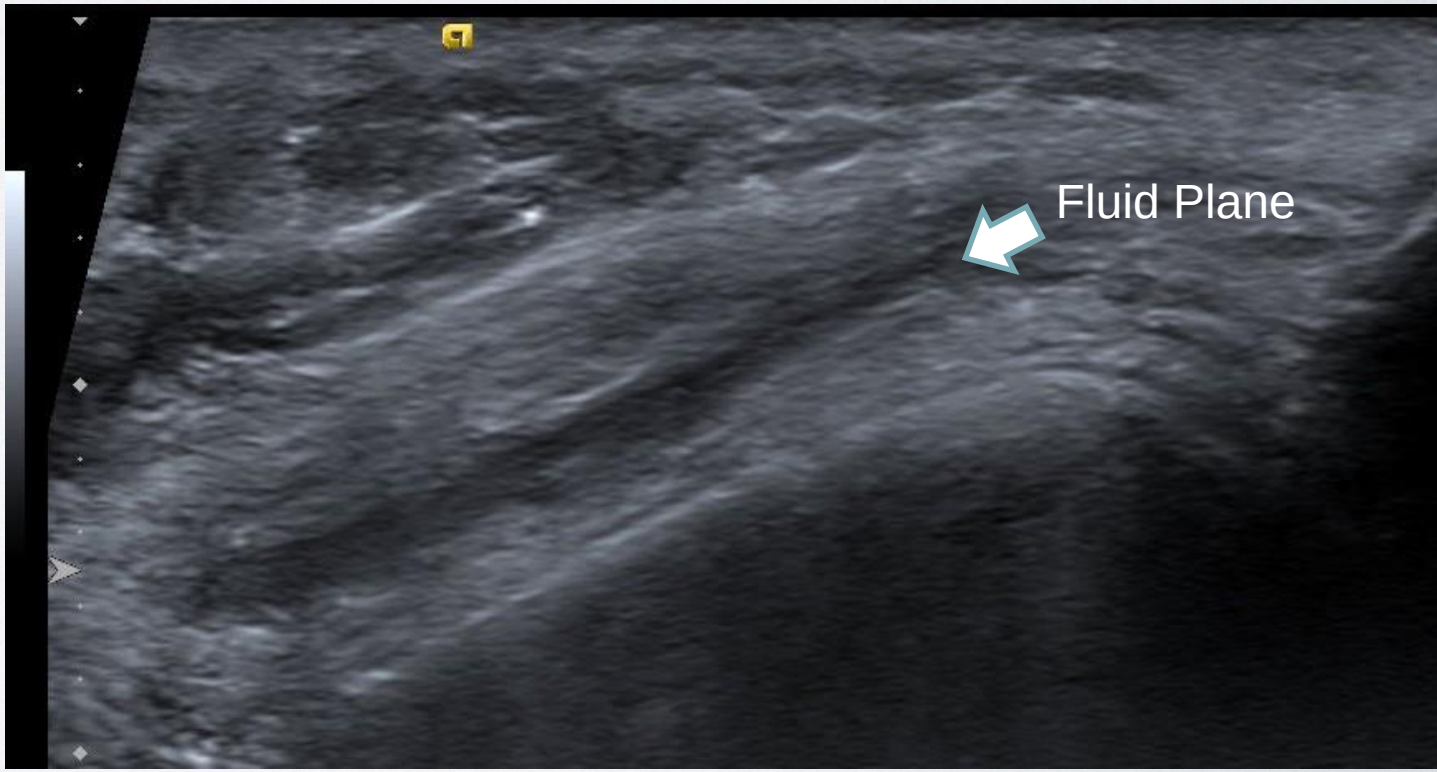
- Patient supine, knee supported with a rolled towel (only if more comfortable).
- Ultrasound-guidance, linear 14MHz transducer.
- 25 or 27-gauge 1.5-inch needle.
- 1% Lidocaine, average 3 cc, superficial and deep to separate the retinaculum from surrounding scar.
    - Superficial first for anesthetic purposes as these can be fairly painful. Beware of air bubbles!
- Post- injection images/dynamics/”squeeze” test.

HYDRODISSECTION OF TETHERED RETINACULUM SCAR





HYDRODISSECTION OF TETHERED RETINACULUM SCAR



RETROSPECTIVE STUDY AT CCF PERFORMED 2015-2019

- **Purpose:** To assess the use of ultrasound-guided hydrodissection plus advanced soft tissue PT to reduce pain and improve function in patients with painful postsurgical or posttraumatic retinacular scar.

STUDY PARAMETERS

- Patients with anterior knee pain from retinacular scar who had failed PT and subsequently had undergone ultrasound-guided patellar retinaculum scar hydrodissection followed by advanced soft tissue PT.
- Pain severity (on a 10-point scale) was assessed before treatment and 6 to 8 times after treatment. 150-day follow-up.
- Return to baseline function was assessed at the same time points after treatment.
- Requirement for subsequent surgery was recorded.
- Results were compared between patients who followed the complete postprocedural protocol (compliant) and those who did not (noncompliant).

RESULTS

- 96 patients with painful retinacular scar
  - 37 underwent ultrasound-guided hydrodissection.
  - Nine patients were lost to follow-up.
  - The final sample consisted of 33 retinacula in 28 patients (mean age, 27 ± 14 y).

RESULTS

67% (22/33) of retinacula were in the COMPLIANT group. Overall, the pain score decreased by 6 points, with 82% of retinacula cases achieving ≥75% subjective return to baseline function and only 5% requiring surgery

Pain scores in the NONCOMPLIANT group decreased by 2 points, with 0% of retinacula cases achieving return to baseline function and 45% requiring surgery.

	Patient did not follow PT protocol	Patient followed PT protocol
Number of retinacula	11	22
Median follow-up length in days (IQR)	42 (115)	75 (77)
Median change in pain score from pretreatment to last follow-up	–2	–6
Cases in which return to baseline function was ≥75% at last follow-up	0 (0%)	18 (82%)
Cases in which pain decreased ≥2 points (relative to pretreatment) at any point during follow-up	7 (64%)	21 (95%)
Cases requiring surgery	5 (45%)	1 (5%)

CONCLUSIONS

- Ultrasound-guided hydrodissection plus advanced soft tissue PT of postsurgical or posttraumatic retinacular scar leads to reduced pain and improved function.
- Longer follow-up, larger cohort studies are needed to assess long-term success.

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SUMMARY

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- Describe the preliminary data comparing the ultrasound findings of fPAES to patient outcomes with different treatment plans.
- Describe the technique for ultrasound guided hydrodissection of patellar retinacular scar and the preliminary short-term outcomes results following this treatment.

- QUESTIONS?

Thank you for your attention!

Tricia Delzell, MD
dpacdelzell@gmail.com
www.advancedmmc.com